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A Unified Framework to Reconcile Different Approaches of Modeling Transpiration Response to Water Stress: Plant Hydraulics, Supply Demand Balance, and Empirical Soil Water Stress Function

Background/Objective

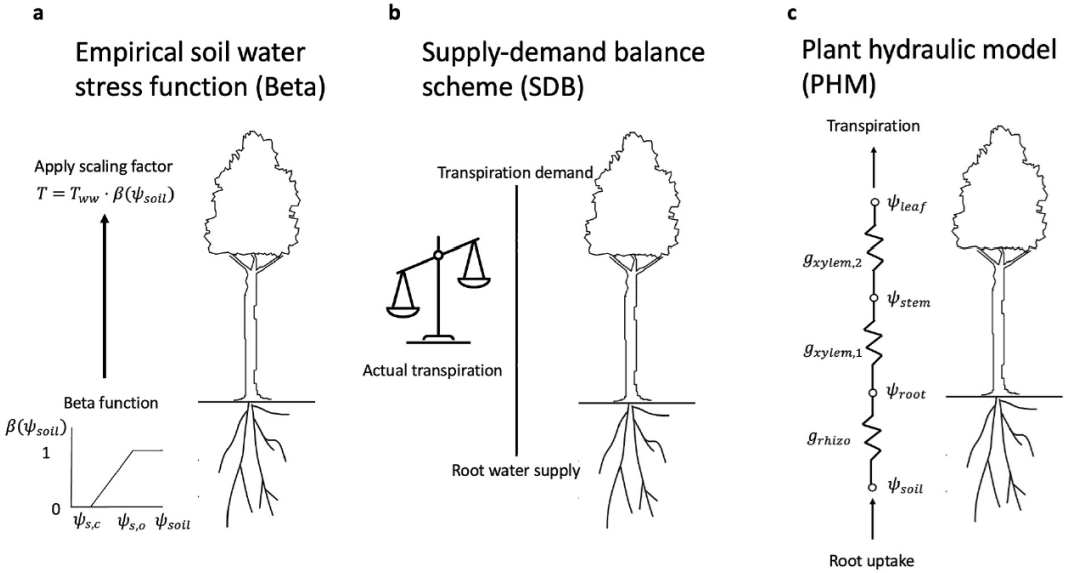
Plant response to water stress is a major component of how ecosystems respond to drought. However, the relationship between historically used empirical drought-stress models and more recently adopted plant hydraulic models (PHMs) are not fully understood, hindering the ability to make informed decisions about the most appropriate modeling approach for a given application. This synthesis study addresses this challenge by introducing a unified framework for modeling transpiration responses to water stress.

Approach

Researchers developed a unified framework for modeling transpiration response to water stress incorporating empirical methods (Beta and supply demand balance (SDB)) and mechanistic based PHMs. After evaluating the response differences of these models, they proposed a method for assessing which conditions necessitate adding complexity to the PHM. They tested those assumptions for three typical ecosystem types.

Results

This work demonstrates that the empirical approaches were special cases of the full PHM. Beta function overestimated transpiration when VPD is high and was therefore not suitable for high VPD applications.



Conceptual diagram of three approaches for modeling plant water stress effects on transpiration.

Significance/Impacts

This work advances the modeling capabilities of plant water stress and provides a framework for researchers to use for choosing the appropriate modeling approach for a given system.

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